Taste and Mouthfeel in Low Calorie Soft Drinks

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Since a few decades there is a considerable increase in the use of low-calorie sweeteners, especially in soft drinks. Although sweetness can be achieved by many of these high intensity sweeteners, differences are still observed when compared with the traditional carbohydrate sweeteners, such as glucose, fructose and sucrose. Clearly the high intensity sweeteners do not give the same sweetness impression (taste and mouthfeel), often have a different time-intensity profile, and bitter aftertastes are observed. Although these deficiencies can to some extent be made less pronounced by using mixtures of high intensity sweeteners, or combinations with carbohydrate sweeteners, some sensory aspects remain unsatisfactory. The term mouthfeel, when used in connection with beverages, includes a series of mouth sensations, such as body (opposite of emptiness), mouth coating, thickness (viscosity), smoothness (homogeneity), astringency, dryness, etc. Mouthfeel is more difficult to evaluate in beverages than in other food systems, due to the short time and low intensity, and therefore requires specialised evaluation. Since Aspartame is at the moment the most used high intensity sweetener, our work in this area has focused on upgrading the impact of this sweetener.

The past few years have shown exciting developments in beverages - particularly in the sweeteners area. As we have moved forward, our studies into their mode of action have begun to unravel many secrets and will continue to do so. Similar developments in understanding the mechanisms behind taste, mouthfeel and other gustatory and tactile effects can be expected - all of which could lead to new and better products.

The development of low calorie foods has progressed dramatically over the last few years - but replacement of all the high calorie ingredients in a foodstuff by low calorie materials does not always enable good products to be formulated.

To define what is lacking in a soft drink which is sweetened by a high intensity low calorie sweetener we should look more closely at the overall perception of a beverage. Four types of sensations can be distinguished, and it is the combination of these which produces the overall impression of a product. These 4 sensations include taste, smell, mouthfeel and appearance (see Figure 1).

Mouthfeel is defined as the textural characteristics perceived in the mouth. The term mouthfeel has been described by Szczesniak [1] as "The composite of the structural elements f the food and the manner in which it registers with the physiological senses". The following descriptors can be distinguished: viscosity, carbonation, body, smoothness, coating, chemical irritation, aftertaste and temperature.

Texture and mouthfeel are important properties of all food products, and it appears that mouthfeel is important for low calorie products, because many low calorie products seem to have undesirable or insufficient mouthfeel characteristics.

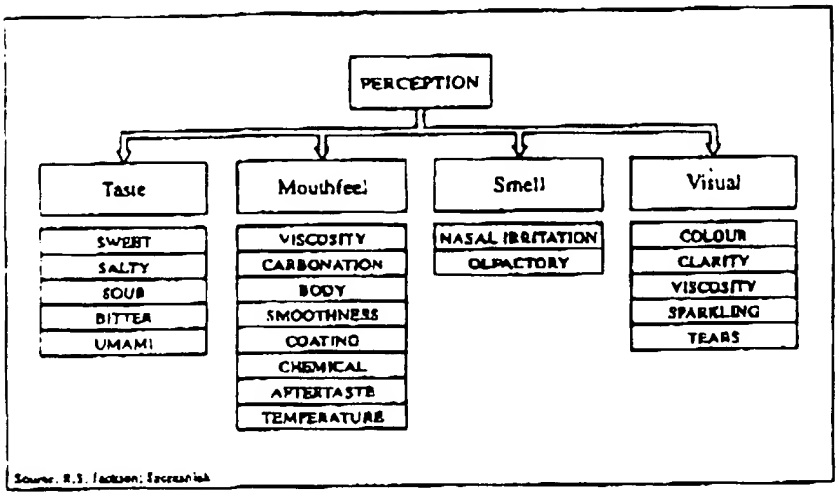

Figure 1. Perception Characteristics of Soft Drinks.

Characteristics or attributes of taste and mouthfeel vary with the application. In soft drinks, the most important differences between a regular sweetened soft drink and that of an artificial or non-nutritive sweetened product [2–4] are determined by:

-the time-intensity profile (sugars tend to give cloying)
-the aftertaste (most artificial sweeteners have a bitter aftertaste)
-the sweetness impression (most artificial sweeteners are "empty" in comparison with sucrose)

When an artificially sweetened soft drink is compared to an equally sweet soft drink, sweetened by sucrose, the artificially sweetened soft drink does not seem to give the full sweetness impression which is experienced when tasting the sucrose sweetened soft drink. The reason for this is not immediately clear, but this could be a mouthfeel effect, a taste effect, or a combination of both.

Interestingly, blends of sweeteners enable sweetness profiles to come much closer to those of sucrose, together with a time-intensity relationship for release of sweetness that is more acceptable to consumers (see Figure 2). Moreover, blends of sweeteners are often synergistic, and are therefore up to 40% more cost effective in their performance. In our experience blends of Aspartame, Acesulfam K, and Sucralose give a sweetness impression closest to sucrose.

In the end, it is the consumer who will decide. We often carry out consumer tests on our concept soft drinks, and the result of one such test is given here, where preferences of various subgroups are shown for a Cola sweetened with a blend of high intensity sweeteners versus a straight Aspartame sweetened one (see Figure 3).

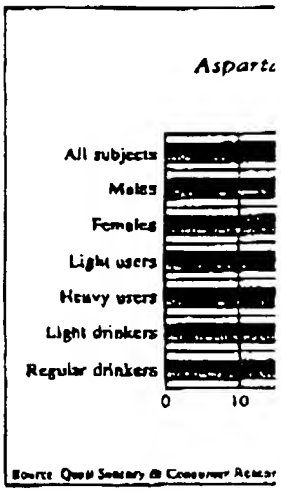

Figure 2. Cola Preference Te
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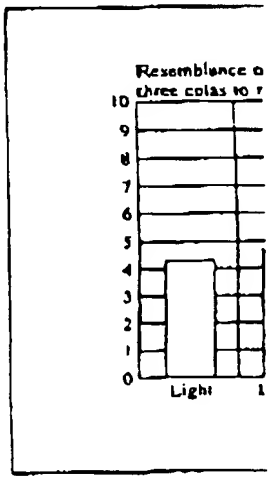

Figure 3. Consumer Percep
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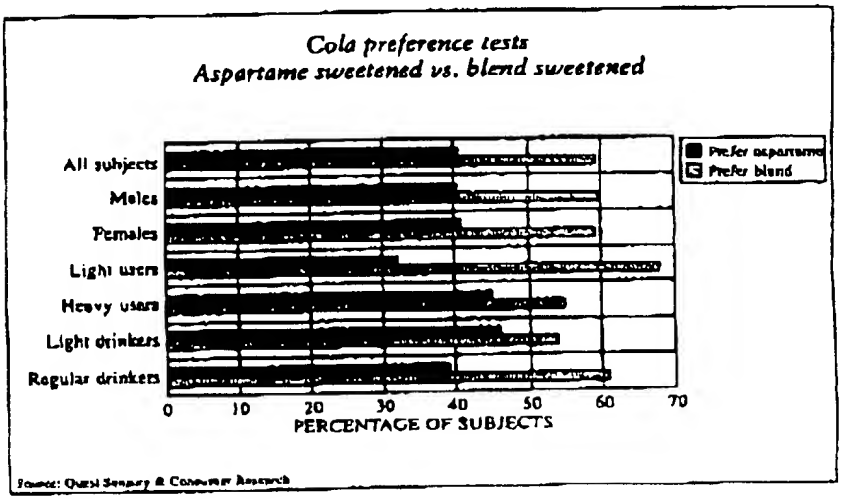

Figure 2. Cola Preference Test (N=113). (Aspartame sweetened: 2.4 g/L; Blend: 0.6 g/L Aspartame, 0.6 g/L Acesulfam-K, 0.3 g/L sucralose).

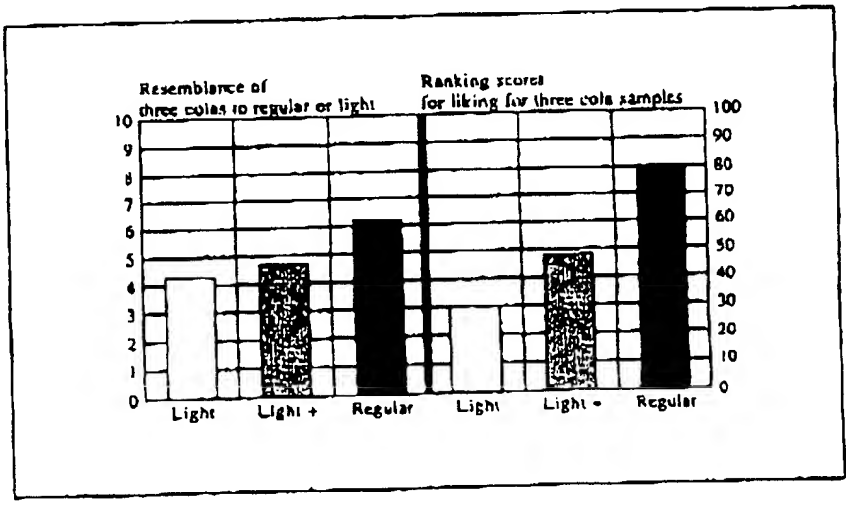

Figure 3. Consumer Perception of Three Colas. (Light: 0.1 g/L Aspartame, 0.1 g/L Acesulfam; Light+: idem + glycerol and sweet flavor; Regular: 10% sucrose).

Not shown, however, are the age preferences - which can perhaps be important. People under 20 were equally split on preference, but at ages above 20 (especially 21 to 30) the blend was significantly preferred.

There seems to be some supporting evidence for the hypothesis that sweetness can be divided into gustatory and tactile effects, just like astringency.

In case of astringency it is bitterness (a gustatory sense) and dryness (a tactile sense). Addition of sucrose to a tannin solution does not only decrease the bitterness (as you would expect), but also modifies (decreases) the perception of the dryness of a product [5]. Using Aspartame in place of sucrose will decrease the bitterness, but will not improve the dryness perception as much. This suggests the significance of mouthfeel aspects when comparing sugar sweetened drinks with artificially sweetened ones. On the other hand, the work of Gassmann [6] on thickened, artificially sweetened drinks indicates that viscosity modification alone is not capable of fully correcting the sensory deficiencies.

The existence of sucrose antagonists [7] could possibly shine some light on the apparent dual character of sucrose. For this purpose dl-2-(4-methoxy-phenoxy)propionic acid (gymnemic acid) was used.

This antagonist was used to take away the sweet taste of a 10% sucrose containing soft drink. Interestingly, not only does the sweetness disappear, but also the mouthfeel! This suggests that the sensory impression of sugar is primarily a gustatory effect, and much less a tactile effect.

EXPERIMENTAL RESULTS

When looking at the influence of specific additives in soft drinks containing Aspartame, the following results were observed:

Carbohydrates. Pectins (both high and low methoxy), and cellulose derivatives gave some improvement in sweetness impression (due to viscosity increase?), but this was limited. Although it is clear that viscosity in drinks affects the tactile receptor system, increasing the viscosity does not seem to make a low calorie sweetened soft drink come closer to a sucrose sweetened soft drink (see also Gassmann [6]).

Amino acids and proteins. Both can deliver improvement in sweetness impression, but certain proteins are better. If the correct protein source can be selected, then the bitter aftertaste of for example, soy proteins can perhaps be alleviated, leaving the benefits. Certain cell wall proteins, for example mannoproteins from yeast, can show positive effects.

Yeast extracts. These can certainly give body / mouthfeel effects in a variety of beverages. Most (logically) suffer from a savoury off taste, but the mouthfeel effects are marked. Perhaps by selection of raw materials, yeast propagation and post-fermentation treatment, this route could yield very interesting products. The ribotide content of a yeast extract could be very important here.

Flavour ingredients. It was observed that certain flavour ingredients or mixtures thereof can give positive effects - for example maltol [8]. Although the use of sweet flavours

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certainly improves the sweetness impression of artificially sweetened soft drinks, additional additives are required to further improve the sensory quality.

DISCUSSION

Taste and mouthfeel are complex issues, but it is to be expected that the next few years will see a range of ingredients which can improve significantly the negatives currently associated with some beverages. This will be enhanced as our understanding of the underlying mechanisms of perception (gustatory and tactile) are elucidated, and we realize how to influence or modify this perception.

In the literature [9] substantial evidence exists for a multiple receptor mechanism of sweet taste. This could possibly explain the sensory observations of high-potency sweeteners in comparison with polyol sweeteners. Polyol sweeteners tend to give a full sweetness impression, which seems to be related to the descriptors "body" and "fullness".

If sugars activate all the receptor types and if activation of all receptor types is required for a full sweetness impression, then high potency sweeteners activating only a limited number of these receptor types would not give the same full sweetness impression. The improvement in sweetness perception caused by blends of high potency sweeteners can also be understood using this concept. However, sweetness is only one aspect of the story - and the use of blends of intensive sweeteners is a step forward. Aftertaste, time-intensity profile, sweetness impression and flavour performance all deserve further improvement .

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